

WHAT IS CLAIMED IS:

1. A portable apparatus for measuring properties of a surface, comprising:

an electromagnetic energy system operable to generate a first beam of electromagnetic energy exiting a port of the apparatus at an angle that is near normal to a surface plane and to generate a second beam of electromagnetic energy exiting the port at an angle that is near grazing to the surface plane;

an integrator operable to receive portions of the first and second beams of electromagnetic energy that are reflected at the surface plane; and

a processor coupled to the integrator and operable to receive communication from the integrator associated with the reflected portions of the first and second beams of electromagnetic energy and to convert the communication to at least one reflectance characteristic value associated with the surface.

2. The portable apparatus of Claim 1, further comprising one or more detectors coupled to the integrator and each operable to respond to a band of electromagnetic energy in the frequency spectrum, the detectors being further operable to communicate data associated with the portions of the first and second beams of electromagnetic energy to the processor.

3. The portable apparatus of Claim 2, further comprising a first reflecting element and a second reflecting element operable to receive portions of the first and second beams of electromagnetic energy respectively, wherein the first reflecting element directs the portion of the first beam of electromagnetic energy that it receives toward the surface at an angle that is near normal to the surface plane, and wherein the second reflecting element directs the portion of the second beam of electromagnetic energy that it receives toward the surface at an angle that is near grazing to the surface plane.

4. The portable apparatus of Claim 3, wherein the first and second reflecting elements are mirrors, and wherein the mirrors each comprise a gold surface.

5. The portable apparatus of Claim 3, further comprising a multiplexer coupled to an analog to digital converter, the multiplexer operable to receive communication from one or more of the detectors via one or more variable gain amplifiers, wherein the analog-to-digital converter is coupled to the multiplexer and operable to receive information from the multiplexer associated with at least one reflectance characteristic of the surface and to communicate the information to the processor.

6. The portable apparatus of Claim 1, further comprising a lens operable to receive and to focus portions of the first and second beams of electromagnetic energy generated by the electromagnetic energy system.

7. The portable apparatus of Claim 1, wherein the processor receives one or more feedback signals from the analog to digital converter and responds to the feedback signals by modifying one or more parameters associated with the electromagnetic energy system.

8. The portable apparatus of Claim 1, further comprising a display operable to receive and to display information communicated by the processor associated with the reflectance characteristic value of the surface.

9. The portable apparatus of Claim 1, further comprising a battery charger operable to receive and to continuously charge a battery, wherein the battery is operable to provide power to the portable apparatus.

10. The portable apparatus of Claim 1, wherein the electromagnetic energy system further comprises a chopper operable to execute a repetitive cycle in which electromagnetic energy that is generated by the electromagnetic energy system is directed by the chopper to a first reflecting element to generate the first beam of electromagnetic energy, then absorbed by the chopper, and then directed to a second reflecting element to generate the second beam of electromagnetic energy, and then absorbed by the chopper.

11. The portable apparatus of Claim 10, wherein the processor is operable to receive data associated with the repetitive cycle, the processor being further operable to distinguish portions of the data which relate to the first and second beams of electromagnetic energy and the portions of the data associated with a frequency, at least some of the data being averaged in order to obtain at least one reflectance characteristic value associated with the surface.

12. The portable apparatus of Claim 10, wherein the processor is operable to receive data associated with the number of cycles executed by the chopper and to generate at least one reflectance characteristic value associated with the surface that is based on the data.

13. The portable apparatus of Claim 1, wherein the processor comprises software operable to guide a user of the portable apparatus through the operation thereof.

14. A method for determining one or more reflectance properties of a surface using a portable apparatus, comprising:

5 reflecting a first beam of electromagnetic energy off of a measured surface, the first beam contacting the measured surface at an angle that is near normal to the measured surface;

10 reflecting a second beam of electromagnetic energy off of the measured surface, the second beam contacting the measured surface at an angle that is near grazing to the measured surface;

15 collecting reflected portions of the first and second beams of electromagnetic energy; and

determining at least one reflectance characteristic value associated with the measured surface based on the reflected portions of the first and second beams of electromagnetic energy.

20 15. The method of Claim 14, further comprising generating the first and second beams of electromagnetic energy with a single electromagnetic energy source.

25 16. The method of Claim 15, further comprising focussing portions of the first and second beams of electromagnetic energy generated by the electromagnetic energy system before the portions reach the measured surface.

17. The method of Claim 16, further comprising modifying one or more parameters associated with the electromagnetic energy source based on one or more feedback signals.

18. The method of Claim 14, further comprising displaying information at a graphical user interface that is associated with one or more reflectance characteristics of the measured surface.

19. The method of Claim 14, further comprising charging a power source contained in the portable apparatus while the portable apparatus is in operation, the power source being operable to provide power to the portable apparatus.

20. The method of Claim 14, further comprising generating the first and second beams of electromagnetic energy from a single electromagnetic energy source using a chopper.

21. The method of Claim 14, further comprising executing a repetitive cycle in which electromagnetic energy is directed to a first reflecting element, then absorbed by an absorptive portion, and then directed to a second reflecting element.

22. The method of Claim 21, further comprising:
receiving data associated with the repetitive cycle;
distinguishing portions of the data which relate to
the first and second beams of electromagnetic energy and
the portions of the data associated with a frequency
band; and

averaging respectively the portions of data in order
to obtain at least one reflectance characteristic value
associated with the measured surface.

23. The method of Claim 14, further comprising
providing a series of instructions to guide a user of the
portable apparatus through the operation thereof.

24. A system for determining one or more reflectance properties of a surface using a portable apparatus, comprising:

5 means for reflecting a first beam of electromagnetic energy off of a measured surface, the first beam contacting the measured surface at an angle that is near normal to the measured surface;

10 means for reflecting a second beam of electromagnetic energy off of the measured surface, the second beam contacting the measured surface at an angle that is near grazing to the measured surface;

15 means for collecting reflected portions of the first and second beams of electromagnetic energy; and

means for determining at least one reflectance characteristic value associated with the measured surface based on the reflected portions of the first and second beams of electromagnetic energy.

20 25. The system of Claim 24, further comprising means for generating the first and second beams of electromagnetic energy with a single electromagnetic energy source.

25 26. The system of Claim 25, further comprising means for focussing portions of the first and second beams of electromagnetic energy generated by the electromagnetic energy system before the portions reach the measured surface.

27. The system of Claim 26, further comprising means for modifying one or more parameters associated with the electromagnetic energy source based on one or more feedback signals.

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28. The system of Claim 24, further comprising means for displaying information at a graphical user interface that is associated with one or more reflectance characteristics of the measured surface.

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29. The system of Claim 24, further comprising means for charging a power source contained in the portable apparatus while the portable apparatus is in operation, the power source being operable to provide power to the portable apparatus.

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30. The system of Claim 24, further comprising means for generating the first and second beams of electromagnetic energy from a single electromagnetic energy source using a chopper.

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31. The system of Claim 24, further comprising means for executing a repetitive cycle in which electromagnetic energy is directed to a first reflecting element, then absorbed by an absorptive portion, and then directed to a second reflecting element.

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32. The system of Claim 31, further comprising:

means for receiving data associated with the repetitive cycle;

5 means for distinguishing portions of the data which relate to the first and second beams of electromagnetic energy and the portions of the data associated with a frequency band; and

10 means for averaging respectively the portions of data in order to obtain at least one reflectance characteristic value associated with the measured surface.

33. The system of Claim 24, further comprising

15 means for providing a series of instructions to guide a user of the portable apparatus through the operation thereof.

34. A portable apparatus for measuring properties of a surface, comprising:

an electromagnetic energy system operable to generate a first beam of electromagnetic energy exiting a port of the apparatus at an angle that is near normal to a surface plane and to generate a second beam of electromagnetic energy exiting the port at an angle that is near grazing to the surface plane;

an integrator operable to receive portions of the first and second beams of electromagnetic energy that are reflected at the surface plane;

a processor coupled to the integrator and operable to receive communication from the integrator associated with the reflected portions of the first and second beams of electromagnetic energy and to convert the communication to at least one reflectance characteristic value associated with the surface;

a first reflecting element and a second reflecting element operable to receive portions of the first and second beams of electromagnetic energy respectively, wherein the first reflecting element directs the portion of the first beam of electromagnetic energy that it receives toward the surface at an angle that is near normal to the surface plane, and wherein the second reflecting element directs the portion of the second beam of electromagnetic energy that it receives toward the surface at an angle that is near grazing to the surface plane;

a chopper operable to execute a repetitive cycle in which electromagnetic energy that is generated by the electromagnetic energy system is directed to the first reflecting element, then absorbed by the chopper, and

then directed to the second reflecting element, and then absorbed by the chopper;

5 one or more detectors coupled to the integrator and each operable to respond to a band of electromagnetic energy in the frequency spectrum, the detectors being further operable to communicate data associated with the portions of the first and second beams of electromagnetic energy to the processor; and

10 a display operable to receive and to display information communicated by the processor associated with the reflectance characteristic value of the surface.

35. A method for determining one or more reflectance properties of a surface using a portable apparatus, comprising:

generating a first beam of electromagnetic energy that propagates toward a surface plane at an angle that is near normal to the surface plane;

generating a second beam of electromagnetic energy that propagates toward the surface plane at an angle that is near grazing to the surface plane;

receiving portions of the first and second beams of electromagnetic energy that are reflected at the surface plane;

receiving the reflected portions of the first and second beams of electromagnetic energy;

providing one or more detectors operable to respond to a frequency band of electromagnetic energy in the frequency spectrum;

receiving an electromagnetic signal from one or more of the detectors via one or more variable gain amplifiers, the signal being associated with the reflected portions of the first and second beams of electromagnetic energy;

multiplexing the electromagnetic signal;

transmitting the electromagnetic signal to an analog to digital converter;

converting the electromagnetic signal from an analog format to a digital format; and
communicating the electromagnetic signal to a processor such that at least one reflectance characteristic of the surface plane may be determined.

36. An electromagnetic energy controller for a portable measuring apparatus, comprising:

5 a chopper operable to transmit a first portion of electromagnetic energy toward a first reflecting element and to reflect a second portion of electromagnetic energy toward a second reflecting element and to absorb a third portion of electromagnetic energy, whereby the chopper executes a repetitive cycle in which the chopper transmits, reflects, and then absorbs portions of
10 electromagnetic energy, wherein the first and second portions of electromagnetic energy are reflected by the first and second reflecting elements respectively toward a surface plane; and

a motor operable to effect motion of the chopper.

15 37. The apparatus of Claim 36, further comprising an electromagnetic energy source operable to generate electromagnetic energy that propagates toward the chopper.

20 38. The apparatus of Claim 36, wherein the chopper comprises two rotating discs, each of the rotating discs including sections operable to facilitate the execution of the repetitive cycle.

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39. The apparatus of Claim 38, wherein part of at least one of the discs comprises a reflective portion that comprises gold-plated aluminum.

5 40. The apparatus of Claim 39, wherein part of at least one of the discs comprises an absorptive portion that comprises aluminum that includes a coating of absorbent paint operable to absorb electromagnetic energy.

10 41. The apparatus of Claim 40, wherein part of at least one of the discs comprises an outer portion defining a cavity therethrough operable to transmit electromagnetic energy substantially unaffected.

15 42. The apparatus of Claim 41, further comprising a processor operable to tune the chopper in response to receiving one or more feedback signals associated with one or more parameters of the chopper.

20 43. The apparatus of Claim 36, further comprising a display operable to receive and to display information associated with the electromagnetic energy reflected at the surface plane.

25 44. The apparatus of Claim 36, further comprising a lens operable to receive and to focus electromagnetic energy received from the chopper.

30 45. The apparatus of Claim 36, wherein the first and second reflecting elements are each mirrors that comprise gold.

46. The apparatus of Claim 36, further comprising a
battery charger operable to receive and to continuously
charge a battery, wherein the battery is operable to
5 provide power to the motor.

47. A method for generating and influencing electromagnetic energy, comprising:

transmitting a first portion of electromagnetic energy toward a first reflecting element;

5 reflecting a second portion of electromagnetic energy toward a second reflecting element;

absorbing a third portion of electromagnetic energy;

executing a repetitive cycle with a chopper, the repetitive cycle comprising the preceding steps of transmitting, reflecting, and absorbing portions of electromagnetic energy, wherein the first and second portions of electromagnetic energy are reflected by the first and second reflecting elements respectively toward a surface plane; and

10 receiving reflected electromagnetic energy from the surface plane.

48. The method of Claim 47, further comprising generating electromagnetic energy that propagates toward the chopper.

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49. The method of Claim 47, wherein the chopper comprises two rotating discs, each of the rotating discs including sections operable to facilitate the execution of the repetitive cycle.

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50. The method of Claim 49, wherein part of at least one of the discs comprises a reflective portion that comprises gold-plated aluminum.

5 51. The method of Claim 50, wherein part of at least one of the discs comprises an absorptive portion that comprises aluminum that includes a coating of absorbent paint operable to absorb electromagnetic energy.

10 52. The method of Claim 51, further comprising transmitting electromagnetic energy substantially unaffected through at least one of the discs having an outer portion defining a cavity therethrough.

15 53. The method of Claim 52, further comprising tuning the chopper in response to receiving one or more feedback signals associated with one or more parameters of the chopper.

20 54. The method of Claim 47, further comprising displaying information associated with the electromagnetic energy reflected at the surface plane.

25 55. The method of Claim 47, further comprising focusing electromagnetic energy received from the chopper.

30 56. The method of Claim 47, further comprising:
effecting motion of the chopper with a motor; and
charging a power source operable to provide power to the motor.

57. A system for generating and influencing electromagnetic energy, comprising:

means for transmitting a first portion of electromagnetic energy toward a first reflecting element;

5 means for reflecting a second portion of electromagnetic energy toward a second reflecting element;

means for absorbing a third portion of electromagnetic energy;

10 means for executing a repetitive cycle with a chopper, the repetitive cycle comprising the preceding steps of transmitting, reflecting, and absorbing portions of electromagnetic energy, wherein the first and second portions of electromagnetic energy are reflected by the first and second reflecting elements respectively toward
15 a surface plane; and

means for receiving reflected electromagnetic energy from the surface plane.

20 58. The system of Claim 57, further comprising means for generating electromagnetic energy that propagates toward the chopper.

25 59. The system of Claim 57, wherein the chopper comprises two rotating discs, each of the rotating discs including sections operable to facilitate the execution of the repetitive cycle.

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60. The system of Claim 59, wherein part of at least one of the discs comprises a reflective portion that comprises gold-plated aluminum.

5 61. The system of Claim 60, wherein part of at least one of the discs comprises an absorptive portion that comprises aluminum that includes a coating of absorbent paint operable to absorb electromagnetic energy.

10 62. The system of Claim 61, further comprising means for transmitting electromagnetic energy substantially unaffected through at least one of the discs having an outer portion defining a cavity therethrough.

15 63. The system of Claim 62, further comprising means for tuning the chopper in response to receiving one or more feedback signals associated with one or more parameters of the chopper.

20 64. The system of Claim 57, further comprising means for displaying information associated with the electromagnetic energy reflected at the surface plane.

25 65. The system of Claim 57, further comprising means for focusing electromagnetic energy received from the chopper.

66. The system of Claim 57, further comprising:

means for effecting motion of the chopper with a
motor; and

5 means for charging a power source operable to
provide power to the motor.

67. An electromagnetic energy controller for a portable measuring apparatus, comprising:

5 a chopper operable to transmit a first portion of electromagnetic energy toward a first reflecting element and to reflect a second portion of electromagnetic energy toward a second reflecting element and to absorb a third portion of electromagnetic energy, whereby the chopper executes a repetitive cycle in which the chopper transmits, reflects, and then absorbs portions of
10 electromagnetic energy, wherein the first and second portions of electromagnetic energy are reflected by the first and second reflecting elements respectively toward a surface plane;

a motor operable to effect motion of the chopper;

15 an electromagnetic energy source operable to generate electromagnetic energy that propagates toward the chopper;

a display operable to receive and to display information associated with the electromagnetic energy reflected at the surface plane; and
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a battery charger operable to receive and to continuously charge a battery, wherein the battery is operable to provide power to the motor.

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68. A method for generating and influencing electromagnetic energy, comprising:

generating electromagnetic energy that propagates toward a chopper;

5 transmitting a first portion of the electromagnetic energy toward a first reflecting element;

reflecting a second portion of the electromagnetic energy toward a second reflecting element;

absorbing a third portion of the electromagnetic energy;

10 executing a repetitive cycle with a chopper, the repetitive cycle comprising the preceding steps of transmitting, reflecting, and absorbing portions of electromagnetic energy, wherein the first and second portions of electromagnetic energy are reflected by the
15 first and second reflecting elements respectively toward a surface plane;

receiving reflected electromagnetic energy from the surface plane;

20 tuning the chopper in response to receiving one or more feedback signals associated with one or more parameters of the chopper; and

displaying information associated with the electromagnetic energy reflected at the surface plane.

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